

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently amended) An acoustic telemetry apparatus for communicating digital data from a down-hole location through a borehole to the surface comprising:
 - an acoustic channel terminated at a down-hole end by a reflecting terminal;
 - an acoustic wave generator located at the surface and providing an acoustic wave carrier signal within said acoustic channel, wherein said signal is continuous;
 - a modulator which is configured to encode said digital data as phase modulation of the reflected carrier wave, and which comprises a resonator located in the vicinity of the reflecting terminal point located at said down-hole location and a valve to open and close access to the resonator and adapted to modulate phase of said carrier wave in response to a digital signal, wherein the modulator and the reflecting terminal form a phase shifting reflector for the carrier wave, switchable between
 - a first state in which the valve closes access to the resonator and closes the downhole end of the acoustic channel and reflects the carrier wave and
 - a second state in which the valve opens access to the resonator which closes the downhole end of the acoustic channel and reflects the carrier wave with a shift in phase relative to reflection by said first state; and
 - one or more sensors located at the surface adapted to detect ~~phase-related~~ information encoded as phase modulation of acoustic waves traveling within said acoustic channel and connected to a decoding unit adapted to convert the detected information into a digital signal.

2-4. (Cancelled)

5. (Previously presented) The apparatus of claim 1 wherein the modulator switches the reflection properties of the reflecting terminal between a first state that causes the phase of an acoustic wave reflected at said terminal to invert and a second state that maintains the original phase of the incident wave.

6. (Original) The apparatus of claim 1 wherein the acoustic channel is a column of liquid extending from the surface to a down-hole location.

7. (Original) The apparatus of claim 6 wherein the acoustic channel is formed by filling an annular volume in the borehole with a liquid.

8. (Original) The apparatus of claim 6 wherein the acoustic channel is formed by filling a tubing string suspended in the borehole with a liquid.

9. (Original) The apparatus of claim 6 wherein the column of liquid has a viscosity of less than 3×10^{-3} NS/m².

10. (Cancelled)

11. (Currently amended) The apparatus of ~~claim 10~~ claim 1 wherein the resonator comprises a liquid filled volume enclosed in a housing having a tubular opening to the reflecting terminal.

12. (Original) The apparatus of claim 11 wherein the resonator has two or more tubular openings to the reflecting terminal.

13. (Original) The apparatus of claim 11 wherein the acoustic wave generator is adapted to simultaneously generate acoustic waves at different frequencies.

14. (Currently amended) The apparatus of claim 1 further comprising an acoustic receiver in a down-hole location ~~adapted to receive acoustic channel in a down-hole location.~~

15-16. (Cancelled)

17. (Original) The apparatus of claim 1 wherein the sensors are connected to a signal processing unit adapted to filter the carrier wave signal from detected information.

18. (Original) The apparatus of claim 1 wherein the modulator comprises a piezoelectric actuator.

19. (Original) The apparatus of claim 1 comprising a down-hole power generator adapted to convert acoustic energy from an acoustic wave signal generated at the surface.

20. (Original) Use of the apparatus of claim 1 in a well stimulation operation.

21. (Currently amended) A method of communicating digital data from a down-hole location through a borehole to the surface comprising the steps of:

establishing an acoustic channel through said borehole and terminating said acoustic channel at a down-hole end by a reflecting terminal;

generating from the surface an acoustic wave carrier signal within said acoustic channel;

~~modulating phase of said carrier wave in response to a digital signal~~ encoding a digital bit stream as modulation of phase of the reflected carrier wave by switching the modulator and the reflecting terminal between a first state which closes the downhole end of the acoustic channel and reflects the carrier wave and a second state which also closes the downhole end of the acoustic channel and which reflects the carrier wave with a shift in phase relative to reflection by said first state; and

detecting at the surface ~~phase-related~~ information encoded as phase modulation of acoustic waves traveling within said acoustic channel, thereby receiving at the surface the digital bit stream encoded as modulation of phase of the carrier wave.

22-23. (Cancelled)

24. (Currently amended) The method of claim 21 further comprising the step of placing a Helmholtz resonator in proximity to the reflecting terminal and the step of modulating encoding a digital bit stream as modulation of phase of said carrier wave comprises switching between a first state in which the resonator is closed thereby closing the downhole end of the acoustic channel and the reflecting terminal reflects the carrier wave and a second state in which the resonator is open to the acoustic channel and closes the downhole end of the acoustic channel so that the reflecting terminal reflects the carrier wave with a shift in phase relative to reflection by said first state.

25. (Currently amended) The method of claim 21 further comprising the steps of performing measurements of down-hole parameters, and encoding said measurements into ~~[[a]]~~ the digital bitstream; ~~and~~ controlling the reflecting properties of the reflecting terminal in response to said encoded bitstream.

26. (Original) The method of claim 21 further comprising the step of selecting the frequency of the carrier wave such that it is close to the resonance frequency of a resonator used to modulate said carrier wave.

27. (Original) The method of claim 21 further comprising the steps of scanning through a range of possible carrier frequencies; monitoring at the surface reflected and modulated wave signal; selecting the frequency of the carrier wave such that the detection of said reflected and modulated wave signal is optimized; and commencing the communication of down-hole measurements.

28. (Previously presented) A method of stimulating a wellbore comprising the steps of performing operations designed to improve the production of said wellbore while simultaneously establishing an acoustic channel through said borehole and terminating said acoustic channel at a down-hole end by a reflecting terminal; performing measurements of down-hole parameters;

encoding said measurements into a digital bit stream;

generating from the surface an acoustic wave carrier signal within said acoustic channel;

~~modulating phase of said carrier wave in response to a digital signal~~ encoding the digital bit stream as modulation of phase of the reflected carrier wave by switching the reflecting terminal between a first state which closes the downhole end of the acoustic channel and reflects the carrier wave and a second state which also closes the downhole end of the acoustic channel and which reflects the carrier wave with a shift in phase relative to reflection by said first state; and

detecting at the surface ~~phase-related~~ information encoded as phase modulation of acoustic waves traveling within said acoustic channel, thereby receiving at the surface the digital bit stream encoded as modulation of phase of the carrier wave.

29-33. (Cancelled)

34. (Previously presented) The apparatus of claim 19, wherein the down-hole power generator is located within the annulus and comprises an electro-acoustic transducer adapted to convert the energy of the acoustic wave into electrical energy.

35. (Previously presented) The apparatus of claim 34, further comprising:
an energy storing capacitor adapted to store the electrical energy and provide power to one or more down-hole devices.

36. (Cancelled)

37. (Currently amended) The apparatus of ~~claim 10~~ claim 1 wherein the resonance frequency of the resonator is close to a frequency of the acoustic wave carrier signal.

38. (Previously presented) The apparatus of claim 11 wherein the reflecting terminal is movable between positions which respectively open and close said housing to the acoustic channel, thereby switching between said first and second states.

39. (Previously presented) The method of claim 21 wherein the acoustic wave carrier signal is continuous.

40. (Currently amended) The method of claim 21 further comprising placing a Helmholtz resonator in proximity to the reflecting terminal, selecting a frequency of the acoustic carrier wave such that it is close to the resonance frequency of said resonator and switching the reflecting terminal between said first and second states by switching between positions which respectively open and close said resonator to the acoustic channel a first state in which the resonator is closed thereby closing the downhole end of the acoustic channel and the reflecting terminal reflects the carrier wave and a second state in which the resonator is open to the acoustic channel and closes the downhole end of the acoustic channel so that the reflecting terminal reflects the carrier wave with a shift in phase relative to reflection by said first state.

41. (Previously presented) The method of claim 28 wherein the acoustic wave carrier signal is continuous.

42. (Currently amended) The method of claim 28 further comprising placing a Helmholtz resonator in proximity to the reflecting terminal, selecting a frequency of the acoustic carrier wave such that it is close to the resonance frequency of said resonator and

switching the reflecting terminal between said first and second states by switching between ~~positions which respectively open and close said resonator to the acoustic channel~~ a first state in which the resonator is closed thereby closing the downhole end of the acoustic channel and the reflecting terminal reflects the carrier wave and a second state in which the resonator is open to the acoustic channel and closes the downhole end of the acoustic channel so that the reflecting terminal reflects the carrier wave with a shift in phase relative to reflection by said first state.

43. (New) The apparatus of claim 1 wherein the acoustic channel is liquid-filled coiled tubing suspended in the borehole.

44. (New) The method of claim 21 wherein establishing the acoustic channel comprises suspending liquid-filled coiled tubing in the borehole.